SSERVI / FINESSE (Field Investigations to Enable Solar System Science and Exploration) Team Highlights.

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Overview: FINESSE (Field Investigations to Enable Solar System Science and Exploration) is an interdisciplinary team of scientists, technologists, and mission operations specialists focused on conducting field-based research to understand geologic processes on the Moon, asteroids, and Phobos & Deimos while simultaneously preparing for future human and robotic exploration of these destinations. FINESSE is led by Principal Investigator (PI) Dr. Jennifer Heldmann and Deputy PIs Drs. Darlene Lim and Anthony Colaprete of NASA Ames Research Center. FINESSE includes team members from government, academia, and industry, including both domestic and international partners. We operate under the philosophy that "*science enables exploration and exploration enables science*."

FINESSE fieldwork at the West Clearwater Impact Structure (WCIS) in northern Canada has focused on age-dating the impact structures. Our research has shown that it is critical to develop strategies for optimal sample selection and precise analysis of small sample masses through terrestrial analog studies to enable geochronology. For WCIS, U/Pb analysis of impact-related zircons by thermal ionization mass spectrometry (TIMS) yielded the most precise age currently available for this impact structure at 286.55 ± 0.33 Ma. Assessment of WCIS samples has demonstrated that the combination of low-precision and high-precision chronometric data obtained through a variety of techniques can improve overall confidence in age assignments for impact craters.

FINESSE fieldwork has also focused on a variety of volcanic processes relevant for the Moon. Fieldwork has been conducted in Idaho, Hawaii, and Iceland as analogs for lunar volcanics. We have investigated the formation of sinuous rilles on the Moon, such as the Hadley Rille visited during Apollo 15, by analyzing the rheology of lunar analog materials. Specifically, by studying the rheology of synthetic KREEP during cooling and crystallization via a series of laboratory experiments, we found that sinuous rille formation on the lunar surface by thermo-mechanical erosion is restricted to lava erupting above the liquidus temperature, when low viscosity allows for turbulent flow regimes. We also studied heat transport which plays a crucial role in the thermal evolution of high-temperature, magmatic regimes on Earth and other planets and moons and found that the thermal conductivity of silicate glasses and liquids relevant for major silicate bodies in the solar system are strongly composition dependent. This finding underscores the importance that models of planetary evolution and igneous processes should use composition-specific thermal conductivity data whenever possible. Our studies of intrinsic geochemical variability in volcanic rift zones and use of terrestrial analogs for magma evolution in sill and dike networks on the Moon have shown that geochemical diversity within terrestrial analog systems enables an improved understanding of expected magmatic complexities in lunar floor-fractured craters, dike-related linear rilles, and silic domes on the Moon.

We have also focused on developing new technologies to optimize future robotic and human exploration of SSERVI Target Bodies. Field instrumentation has been critical for enabling both robust science and understanding the concepts of operations and capabilities required for robotic and human exploration. The FINESSE project has also utilized terrestrial field lidar data of lava tubes and volcanic surface landforms to render these sites in virtual and augmented reality platforms. New analysis tools have been developed within the VR/AR framework to enable scientific measurements and analysis of these analog features, with extensibility to future exploration scenarios for the Moon and other SSERVI Target Bodies.

Public Engagement: FINESSE is committed to publicly sharing our research and interest in planetary science and exploration. FINESSE research is shared through channels including the FINESSE website and social media accounts, as well as NASA flagship accounts like @NASASolarSystem. Samples collected from the field contributed to a kit that will be available for use by FINESSE team members and colleagues in classroom visits and outreach events for years to come. FINESSE continued support for a SSERVI Seminar Series, a virtual seminar series highlighting SSERVI science and related public programs and resources for the NASA Museum Alliance and Solar System Ambassadors. FINESSE scientists presented at universities and K–12 classrooms around the country – and internationally, including a joint presentation by FINESSE leadership at Reykjavik University and a showcase of volcanoes on Earth and throughout the Solar System in a bi-lingual (English/German) 6th grade geography class by team member Alex Sehlke. Erika Rader contributed an article to AGU's Eos describing her experiments at the Syracuse Lava Project, with relevance to similar features on the Moon and Mars.